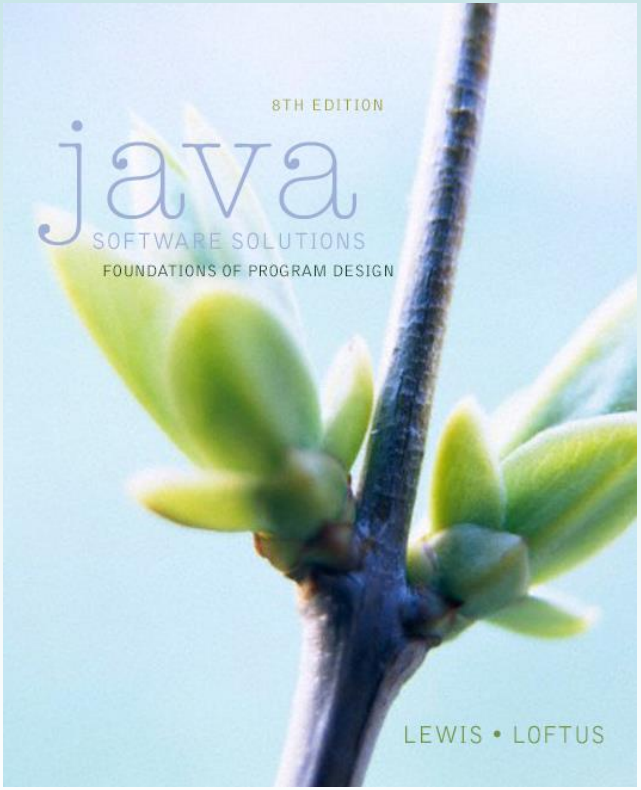
Chapter 5
Conditionals and Loops



Java Software Solutions

Foundations of Program Design

8th Edition

John Lewis
William Loftus

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Conditionals and Loops

- Now we will examine programming statements that allow us to:
  - make decisions
  - repeat processing steps in a loop
- Chapter 5 focuses on:
  - boolean expressions
  - the if and if-else statements
  - comparing data
  - while loops
  - iterators
  - more drawing techniques
  - more GUI components

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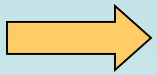
Outline



Boolean Expressions

The `if` Statement

Comparing Data

The `while` Statement

Iterators

The `ArrayList` Class

Determining Event Sources

Check Boxes and Radio Buttons

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Flow of Control

- Unless specified otherwise, the order of statement execution through a method is linear: one after another
- Some programming statements allow us to make decisions and perform repetitions
- These decisions are based on *boolean expressions* (also called *conditions*) that evaluate to true or false
- The order of statement execution is called the *flow of control*

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Conditional Statements

- A *conditional statement* lets us choose which statement will be executed next
- They are sometimes called *selection statements*
- Conditional statements give us the power to make basic decisions
- The Java conditional statements are the:
  - if and if-else statement
  - switch statement
- We'll explore the switch statement in Chapter 6

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Boolean Expressions

- A condition often uses one of Java's *equality operators* or *relational operators*, which all return boolean results:

`==`	equal to
`!=`	not equal to
`<`	less than
`>`	greater than
`<=`	less than or equal to
`>=`	greater than or equal to

- Note the difference between the equality operator (==) and the assignment operator (=)

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Boolean Expressions

- An `if` statement with its boolean condition:

```
if (sum > MAX)
   delta = sum - MAX;
```

- First, the condition is evaluated: the value of `sum` is either greater than the value of `MAX`, or it is not
- If the condition is true, the assignment statement is executed; if it isn't, it is skipped
- See `Age.java`

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```
//********************************************************************
//  Age.java       Author: Lewis/Loftus
//
//  Demonstrates the use of an if statement.
//********************************************************************

import java.util.Scanner;

public class Age
{
   //-----------------------------------------------------------------
   //  Reads the user's age and prints comments accordingly.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      final int MINOR = 21;

      Scanner scan = new Scanner(System.in);

      System.out.print("Enter your age: ");
      int age = scan.nextInt();
```

continue

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continue

```
      System.out.println("You entered: " + age);

      if (age < MINOR)
         System.out.println("Youth is a wonderful thing. Enjoy.");

      System.out.println("Age is a state of mind.");
   }
}
```

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Sample Run

```
Enter your age: 47
You entered: 47
Age is a state of mind.
```

continue

```
        System.out.println("You entered: " + age);

        if (age < MINOR)
           System.out.println("Youth is a wonderful thing. Enjoy.");

        System.out.println("Age is a state of mind.");
    }
}
```

Another Sample Run

```
Enter your age: 12
You entered: 12
Youth is a wonderful thing. Enjoy.
Age is a state of mind.
```

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Logical Operators

- Boolean expressions can also use the following *logical operators*:

`!`	Logical NOT
`&&`	Logical AND
`||`	Logical OR

- They all take boolean operands and produce boolean results
- Logical NOT is a unary operator (it operates on one operand)
- Logical AND and logical OR are binary operators (each operates on two operands)

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Logical NOT

- The *logical NOT* operation is also called *logical negation* or *logical complement*
- If some boolean condition `a` is true, then `!a` is false; if `a` is false, then `!a` is true
- Logical expressions can be shown using a *truth table*:

`a`	`!a`
true	false
false	true

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Logical AND and Logical OR

- The *logical AND* expression

```
a && b
```

  is true if both `a` and `b` are true, and false otherwise

- The *logical OR* expression

```
a || b
```

  is true if `a` or `b` or both are true, and false otherwise

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Logical AND and Logical OR

- A truth table shows all possible true-false combinations of the terms
- Since `&&` and `||` each have two operands, there are four possible combinations of conditions `a` and `b`

a	b	a && b	a || b
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

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Logical Operators

- Expressions that use logical operators can form complex conditions

```
if (total < MAX+5 && !found)
   System.out.println("Processing…");
```

- All logical operators have lower precedence than the relational operators
- The `!` operator has higher precedence than `&&` and `||`

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Boolean Expressions

- Specific expressions can be evaluated using truth tables

`total < MAX`	`found`	`!found`	`total < MAX && !found`
false	false	true	false
false	true	false	false
true	false	true	true
true	true	false	false

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Short-Circuited Operators

- The processing of `&&` and `||` is “short-circuited”
- If the left operand is sufficient to determine the result, the right operand is not evaluated

```
if (count != 0 && total/count > MAX)
   System.out.println("Testing.");
```

- This type of processing should be used carefully

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Outline

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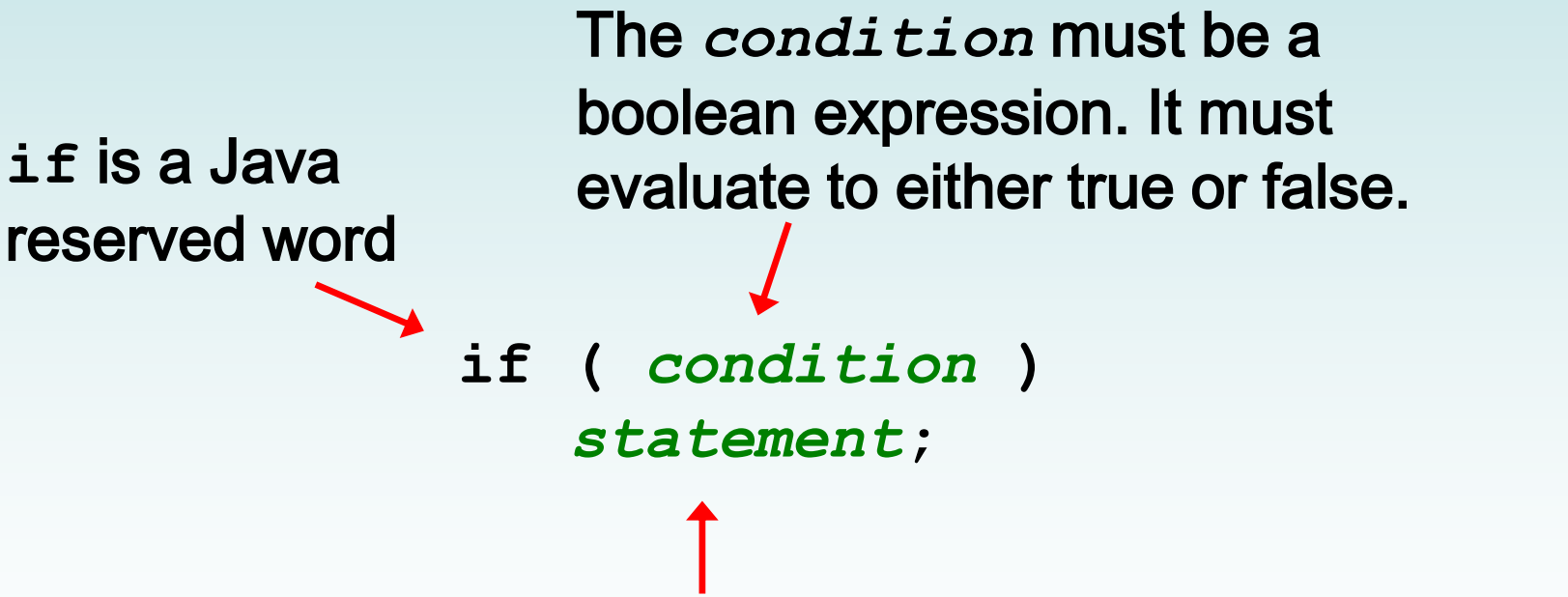
The if Statement

- Let's now look at the `if` statement in more detail
- The *if statement* has the following syntax:


The condition must be a boolean expression. It must evaluate to either true or false.
if is a Java reserved word
if (condition)
statement;
If the condition is true, the statement is executed.
If it is false, the statement is skipped.

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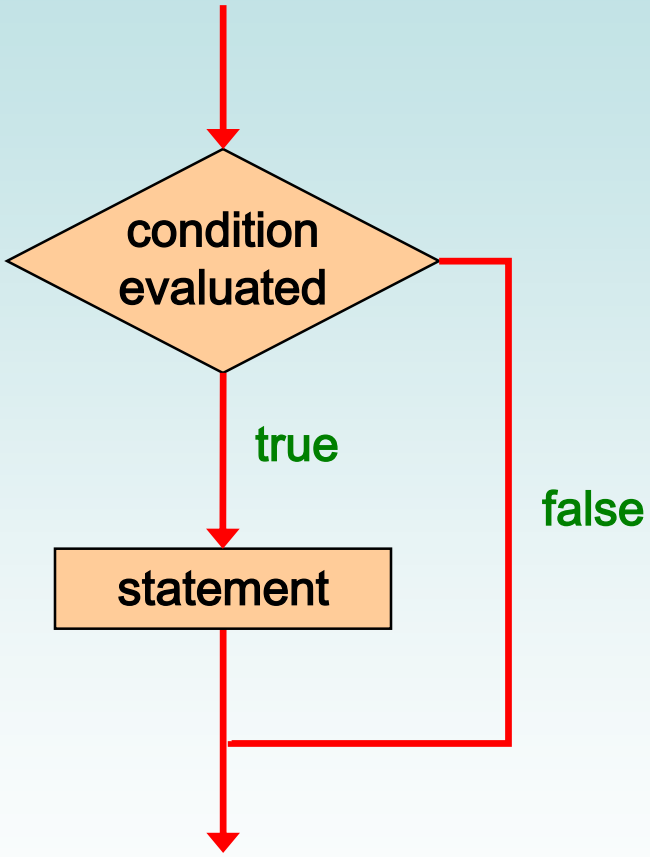
Logic of an if statement



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Indentation

- The statement controlled by the `if` statement is indented to indicate that relationship
- The use of a consistent indentation style makes a program easier to read and understand
- The compiler ignores indentation, which can lead to errors if the indentation is not correct

"Always code as if the person who ends up maintaining your code will be a violent psychopath who knows where you live."

-- Martin Golding

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Quick Check

What do the following statements do?

```
if (total != stock + warehouse)
   inventoryError = true;
```

```
if (found || !done)
   System.out.println("Ok");
```

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Quick Check

What do the following statements do?

```
if (total != stock + warehouse)
   inventoryError = true;
```

Sets the boolean variable to true if the value of `total` is not equal to the sum of `stock` and `warehouse`

```
if (found || !done)
   System.out.println("Ok");
```

Prints "Ok" if `found` is true or `done` is false

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The if-else Statement

- An *else clause* can be added to an `if` statement to make an *if-else statement*

```
if ( condition )
   statement1;
else
   statement2;
```

- If the *condition* is true, *statement1* is executed; if the condition is false, *statement2* is executed
- One or the other will be executed, but not both
- See `Wages.java`

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```
//********************************************************************
//  Wages.java       Author: Lewis/Loftus
//
//  Demonstrates the use of an if-else statement.
//********************************************************************

import java.text.NumberFormat;
import java.util.Scanner;

public class Wages
{
   //-----------------------------------------------------------------
   //  Reads the number of hours worked and calculates wages.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      final double RATE = 8.25;  // regular pay rate
      final int STANDARD = 40;   // standard hours in a work week

      Scanner scan = new Scanner(System.in);

      double pay = 0.0;
```

continue

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continue

```
        System.out.print("Enter the number of hours worked: ");
        int hours = scan.nextInt();

        System.out.println ();

        // Pay overtime at "time and a half"
        if (hours > STANDARD)
           pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
        else
           pay = hours * RATE;

        NumberFormat fmt = NumberFormat.getCurrencyInstance();
        System.out.println("Gross earnings: " + fmt.format(pay));
    }
}
```

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continue

```
        System.
        int hou

        System.

        // Pay overtime at "time and a half"
        if (hours > STANDARD)
           pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
        else
           pay = hours * RATE;

        NumberFormat fmt = NumberFormat.getCurrencyInstance();
        System.out.println("Gross earnings: " + fmt.format(pay));
    }
}
```

Sample Run

```
Enter the number of hours worked: 46

Gross earnings: $404.25
```

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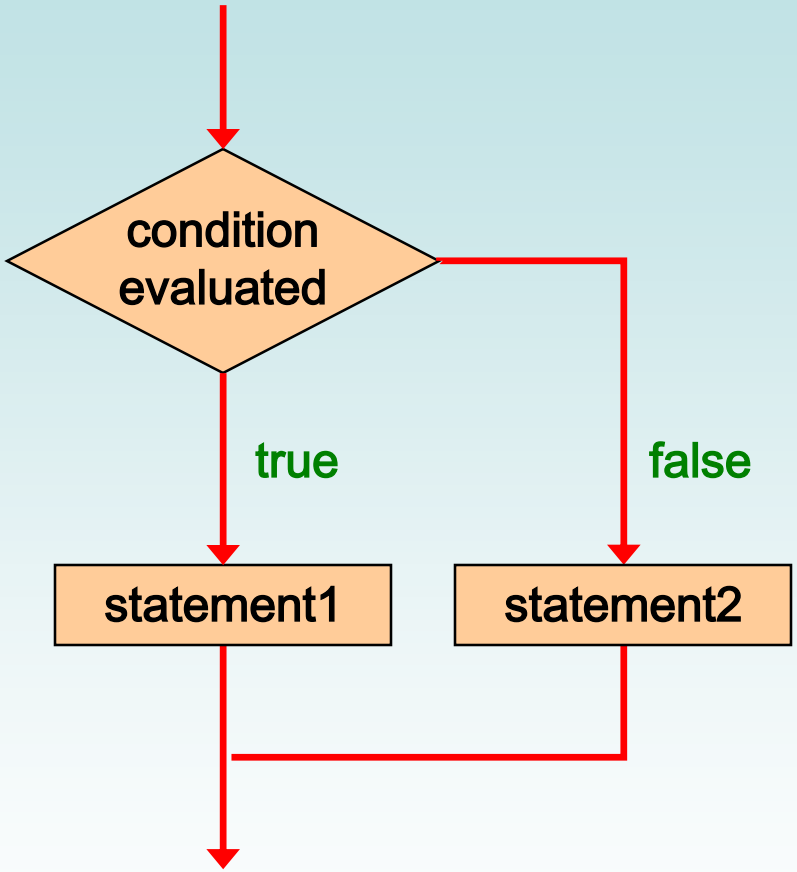
Logic of an if-else statement



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The Coin Class

- Let's look at an example that uses a class that represents a coin that can be flipped
- Instance data is used to indicate which face (heads or tails) is currently showing
- See `CoinFlip.java`
- See `Coin.java`

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```
//********************************************************************
//  CoinFlip.java       Author: Lewis/Loftus
//
//  Demonstrates the use of an if-else statement.
//********************************************************************

public class CoinFlip
{
   //-----------------------------------------------------------------
   //  Creates a Coin object, flips it, and prints the results.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      Coin myCoin = new Coin();

      myCoin.flip();

      System.out.println(myCoin);

      if (myCoin.isHeads())
         System.out.println("You win.");
      else
         System.out.println("Better luck next time.");
   }
}
```

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Sample Run

```
Tails
Better luck next time.
```

```
//********************                                  **********************
//  CoinFlip.java
//
//  Demonstrates the                                    .
//********************                                  **********************

public class CoinFlip
{
   //-----------------------------------------------------------------
   //  Creates a Coin object, flips it, and prints the results.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      Coin myCoin = new Coin();

      myCoin.flip();

      System.out.println(myCoin);

      if (myCoin.isHeads())
         System.out.println("You win.");
      else
         System.out.println("Better luck next time.");
   }
}
```

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```
//********************************************************************
//  Coin.java       Author: Lewis/Loftus
//
//  Represents a coin with two sides that can be flipped.
//********************************************************************

public class Coin
{
   private final int HEADS = 0;
   private final int TAILS = 1;

   private int face;

   //-----------------------------------------------------------------
   //  Sets up the coin by flipping it initially.
   //-----------------------------------------------------------------
   public Coin()
   {
      flip();
   }
```

continue

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continue

```
    //-----------------------------------------------------------------
    //  Flips the coin by randomly choosing a face value.
    //-----------------------------------------------------------------
    public void flip()
    {
       face = (int) (Math.random() * 2);
    }

    //-----------------------------------------------------------------
    //  Returns true if the current face of the coin is heads.
    //-----------------------------------------------------------------
    public boolean isHeads()
    {
       return (face == HEADS);
    }
```

continue

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continue

```
    //-----------------------------------------------------------------
    //  Returns the current face of the coin as a string.
    //-----------------------------------------------------------------
    public String toString()
    {
        String faceName;

        if (face == HEADS)
            faceName = "Heads";
        else
            faceName = "Tails";

        return faceName;
    }
}
```

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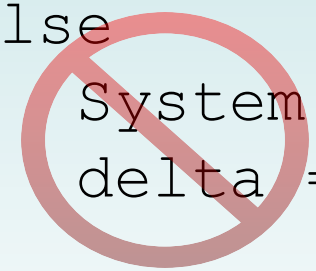
Indentation Revisited

- Remember that indentation is for the human reader, and is ignored by the compiler

```
if (depth >= UPPER_LIMIT)
   delta = 100;
else
   System.out.println("Reseting Delta");
   delta = 0;
```



- Despite what the indentation implies, `delta` will be set to 0 no matter what

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Block Statements

- Several statements can be grouped together into a *block statement* delimited by braces
- A block statement can be used wherever a statement is called for in the Java syntax rules

```
if (total > MAX)
{
   System.out.println("Error!!");
   errorCount++;
}
```

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Block Statements

- The `if` clause, or the `else` clause, or both, could govern block statements

```
if (total > MAX)
{
   System.out.println("Error!!");
   errorCount++;
}
else
{
   System.out.println("Total: " + total);
   current = total*2;
}
```

- See `Guessing.java`

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```
//********************************************************************
//  Guessing.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a block statement in an if-else.
//********************************************************************

import java.util.*;

public class Guessing
{
   //-----------------------------------------------------------------
   //  Plays a simple guessing game with the user.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      final int MAX = 10;
      int answer, guess;

      Scanner scan = new Scanner(System.in);
      Random generator = new Random();

      answer = generator.nextInt(MAX) + 1;
```

continue

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continue

```
      System.out.print("I'm thinking of a number between 1 and "
                       + MAX + ". Guess what it is: ");

      guess = scan.nextInt();

      if (guess == answer)
         System.out.println("You got it! Good guessing!");
      else
      {
         System.out.println("That is not correct, sorry.");
         System.out.println("The number was " + answer);
      }
   }
}
```

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Sample Run

```
I'm thinking of a number between 1 and 10. Guess what it is: 6
That is not correct, sorry.
The number was 9
```

```
      if (guess == answer)
         System.out.println("You got it! Good guessing!");
      else
      {
         System.out.println("That is not correct, sorry.");
         System.out.println("The number was " + answer);
      }
   }
}
```

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Nested if Statements

- The statement executed as a result of an `if` or `else` clause could be another `if` statement
- These are called *nested if statements*
- An `else` clause is matched to the last unmatched `if` (no matter what the indentation implies)
- Braces can be used to specify the `if` statement to which an `else` clause belongs
- See `MinOfThree.java`

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```
//********************************************************************
//  MinOfThree.java       Author: Lewis/Loftus
//
//  Demonstrates the use of nested if statements.
//********************************************************************

import java.util.Scanner;

public class MinOfThree
{
   //-----------------------------------------------------------------
   //  Reads three integers from the user and determines the smallest
   //  value.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      int num1, num2, num3, min = 0;

      Scanner scan = new Scanner(System.in);

      System.out.println("Enter three integers: ");
      num1 = scan.nextInt();
      num2 = scan.nextInt();
      num3 = scan.nextInt();
```

continue

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continue

```
        if (num1 < num2)
            if (num1 < num3)
                min = num1;
            else
                min = num3;
        else
            if (num2 < num3)
                min = num2;
            else
                min = num3;

        System.out.println("Minimum value: " + min);
    }
}
```

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continue

```
        if (num1 < num2)
            if (num1 < num3)
                min = num1;
            else
                min = num3;
        else
            if (num2 < num3)
                min = num2;
            else
                min = num3;

        System.out.println("Minimum value: " + min);
    }
}
```

Sample Run

```
Enter three integers:
84   69   90
Minimum value: 69
```

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Outline

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Comparing Data

- When comparing data using boolean expressions, it's important to understand the nuances of certain data types
- Let's examine some key situations:
  - Comparing floating point values for equality
  - Comparing characters
  - Comparing strings (alphabetical order)
  - Comparing object vs. comparing object references

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Comparing Float Values

- You should rarely use the equality operator (`==`) when comparing two floating point values (`float` or `double`)
- Two floating point values are equal only if their underlying binary representations match exactly
- Computations often result in slight differences that may be irrelevant
- In many situations, you might consider two floating point numbers to be "close enough" even if they aren't exactly equal

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Comparing Float Values

- To determine the equality of two floats, use the following technique:

```
if (Math.abs(f1 - f2) < TOLERANCE)
    System.out.println("Essentially equal");
```

- If the difference between the two floating point values is less than the tolerance, they are considered to be equal

- The tolerance could be set to any appropriate level, such as 0.000001

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Comparing Characters

- As we've discussed, Java character data is based on the Unicode character set
- Unicode establishes a particular numeric value for each character, and therefore an ordering
- We can use relational operators on character data based on this ordering
- For example, the character `'+'` is less than the character `'J'` because it comes before it in the Unicode character set
- Appendix C provides an overview of Unicode

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Comparing Characters

- In Unicode, the digit characters (0-9) are contiguous and in order
- Likewise, the uppercase letters (A-Z) and lowercase letters (a-z) are contiguous and in order

Characters	Unicode Values
0 – 9	48 through 57
A – Z	65 through 90
a – z	97 through 122

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Comparing Strings

- Remember that in Java a character string is an object
- The `equals` method can be called with strings to determine if two strings contain exactly the same characters in the same order
- The `equals` method returns a boolean result

```
if (name1.equals(name2))
   System.out.println("Same name");
```

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Comparing Strings

- We cannot use the relational operators to compare strings
- The `String` class contains the `compareTo` method for determining if one string comes before another
- A call to `name1.compareTo(name2)`
  - returns zero if `name1` and `name2` are equal (contain the same characters)
  - returns a negative value if `name1` is less than `name2`
  - returns a positive value if `name1` is greater than `name2`

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Comparing Strings

- Because comparing characters and strings is based on a character set, it is called a *lexicographic ordering*

```
int result = name1.comareTo(name2);
if (result < 0)
   System.out.println(name1 + "comes first");
else
   if (result == 0)
      System.out.println("Same name");
   else
      System.out.println(name2 + "comes first");
```

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Lexicographic Ordering

- Lexicographic ordering is not strictly alphabetical when uppercase and lowercase characters are mixed
- For example, the string `"Great"` comes before the string `"fantastic"` because all of the uppercase letters come before all of the lowercase letters in Unicode
- Also, short strings come before longer strings with the same prefix (lexicographically)
- Therefore `"book"` comes before `"bookcase"`

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Comparing Objects

- The == operator can be applied to objects – it returns true if the two references are aliases of each other
- The `equals` method is defined for all objects, but unless we redefine it when we write a class, it has the same semantics as the == operator
- It has been redefined in the `String` class to compare the characters in the two strings
- When you write a class, you can redefine the `equals` method to return true under whatever conditions are appropriate

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Repetition Statements

- *Repetition statements* allow us to execute a statement multiple times
- Often they are referred to as *loops*
- Like conditional statements, they are controlled by boolean expressions
- Java has three kinds of repetition statements: `while`, `do`, and `for` loops
- The `do` and `for` loops are discussed in Chapter 6

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The while Statement

- A *while statement* has the following syntax:

```
while ( condition )
    statement;
```

- If the **condition** is true, the **statement** is executed
- Then the condition is evaluated again, and if it is still true, the statement is executed again
- The statement is executed repeatedly until the condition becomes false

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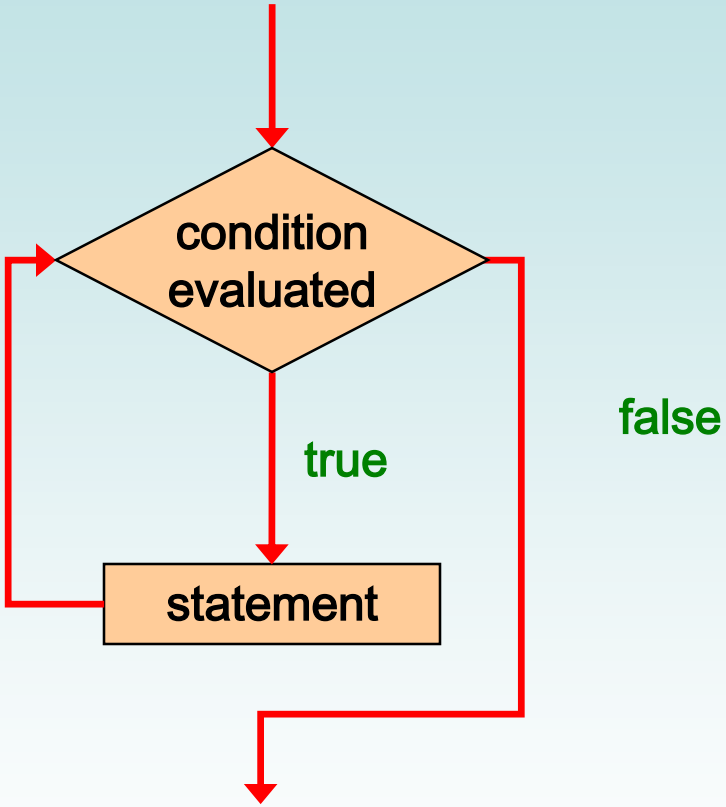
Logic of a while Loop



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The while Statement

- An example of a while statement:

```
int count = 1;
while (count <= 5)
{
   System.out.println(count);
   count++;
}
```

- If the condition of a `while` loop is false initially, the statement is never executed
- Therefore, the body of a `while` loop will execute zero or more times

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Sentinel Values

- Let's look at some examples of loop processing
- A loop can be used to maintain a *running sum*
- A *sentinel value* is a special input value that represents the end of input
- See `Average.java`

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```
//********************************************************************
//  Average.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a while loop, a sentinel value, and a
//  running sum.
//********************************************************************

import java.text.DecimalFormat;
import java.util.Scanner;

public class Average
{
   //-----------------------------------------------------------------
   //  Computes the average of a set of values entered by the user.
   //  The running sum is printed as the numbers are entered.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      int sum = 0, value, count = 0;
      double average;

      Scanner scan = new Scanner(System.in);

      System.out.print("Enter an integer (0 to quit): ");
      value = scan.nextInt();
```

continue

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continue

```
        while (value != 0)  // sentinel value of 0 to terminate loop
        {
           count++;

           sum += value;
           System.out.println("The sum so far is " + sum);

           System.out.print("Enter an integer (0 to quit): ");
           value = scan.nextInt();
        }
```

continue

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continue

```
        System.out.println();

        if (count == 0)
           System.out.println("No values were entered.");
        else
        {
           average = (double)sum / count;

           DecimalFormat fmt = new DecimalFormat("0.###");
           System.out.println("The average is " + fmt.format(average));
        }
    }
}
```

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continue

```
        System.ou

        if (count
            System
        else
        {
            average

            Decima
            System
        }
    }
}
```

```
at(average));
```

Sample Run

```
Enter an integer (0 to quit): 25
The sum so far is 25
Enter an integer (0 to quit): 164
The sum so far is 189
Enter an integer (0 to quit): -14
The sum so far is 175
Enter an integer (0 to quit): 84
The sum so far is 259
Enter an integer (0 to quit): 12
The sum so far is 271
Enter an integer (0 to quit): -35
The sum so far is 236
Enter an integer (0 to quit): 0

The average is 39.333
```

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Input Validation

- A loop can also be used for *input validation*, making a program more *robust*
- It's generally a good idea to verify that input is valid (in whatever sense) when possible
- See `WinPercentage.java`

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```
//********************************************************************
//  WinPercentage.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a while loop for input validation.
//********************************************************************

import java.text.NumberFormat;
import java.util.Scanner;

public class WinPercentage
{
   //-----------------------------------------------------------------
   //  Computes the percentage of games won by a team.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      final int NUM_GAMES = 12;
      int won;
      double ratio;

      Scanner scan = new Scanner(System.in);

      System.out.print("Enter the number of games won (0 to "
                       + NUM_GAMES + "): ");
      won = scan.nextInt();
```

continue

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continue

```
      while (won < 0 || won > NUM_GAMES)
      {
         System.out.print("Invalid input. Please reenter: ");
         won = scan.nextInt();
      }

      ratio = (double)won / NUM_GAMES;

      NumberFormat fmt = NumberFormat.getPercentInstance();

      System.out.println();
      System.out.println("Winning percentage: " + fmt.format(ratio));
   }
}
```

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continue

```
        while
        {
            Sy
            wo
        }

        ratio = (double)won / NUM_GAMES;

        NumberFormat fmt = NumberFormat.getPercentInstance();

        System.out.println();
        System.out.println("Winning percentage: " + fmt.format(ratio));
    }
}
```

Sample Run

```
Enter the number of games won (0 to 12): -5
Invalid input. Please reenter: 13
Invalid input. Please reenter: 7

Winning percentage: 58%
```

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Infinite Loops

- The body of a `while` loop eventually must make the condition false
- If not, it is called an *infinite loop*, which will execute until the user interrupts the program
- This is a common logical error
- You should always double check the logic of a program to ensure that your loops will terminate normally

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Infinite Loops

- An example of an infinite loop:

```
int count = 1;
while (count <= 25)
{
   System.out.println(count);
   count = count - 1;
}
```

- This loop will continue executing until interrupted (Control-C) or until an underflow error occurs

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Nested Loops

- Similar to nested `if` statements, loops can be nested as well
- That is, the body of a loop can contain another loop
- For each iteration of the outer loop, the inner loop iterates completely
- See `PalindromeTester.java`

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```
//********************************************************************
//  PalindromeTester.java       Author: Lewis/Loftus
//
//  Demonstrates the use of nested while loops.
//********************************************************************

import java.util.Scanner;

public class PalindromeTester
{
   //-----------------------------------------------------------------
   //  Tests strings to see if they are palindromes.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      String str, another = "y";
      int left, right;

      Scanner scan = new Scanner(System.in);

      while (another.equalsIgnoreCase("y"))  // allows y or Y
      {
         System.out.println("Enter a potential palindrome:");
         str = scan.nextLine();

         left = 0;
         right = str.length() - 1;
```

continue

n, Inc.

continue

```
            while (str.charAt(left) == str.charAt(right) && left < right)
            {
               left++;
               right--;
            }

            System.out.println();

            if (left < right)
               System.out.println("That string is NOT a palindrome.");
            else
               System.out.println("That string IS a palindrome.");

            System.out.println();
            System.out.print("Test another palindrome (y/n)? ");
            another = scan.nextLine();
         }
      }
   }
```

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continue

```
            while
            {
               lef
               rig
            }

            System

            if (le
               Sys
            else
               Sys

            System
            System
            anothe
         }
      }
}
```

```
& left < right)

alindrome.");

drome.");

n)? ");
```

Sample Run

```
Enter a potential palindrome:
radar

That string IS a palindrome.

Test another palindrome (y/n)? y
Enter a potential palindrome:
able was I ere I saw elba

That string IS a palindrome.

Test another palindrome (y/n)? y
Enter a potential palindrome:
abracadabra

That string is NOT a palindrome.

Test another palindrome (y/n)? n
```

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Quick Check

How many times will the string "Here" be printed?

```
count1 = 1;
while (count1 <= 10)
{
   count2 = 1;
   while (count2 < 20)
   {
      System.out.println("Here");
      count2++;
   }
   count1++;
}
```

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Quick Check

How many times will the string "Here" be printed?

```
count1 = 1;
while (count1 <= 10)
{
   count2 = 1;
   while (count2 < 20)
   {
      System.out.println("Here");
      count2++;
   }
   count1++;
}
```

10 * 19 = 190

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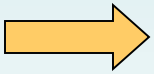
Outline



Boolean Expressions

The `if` Statement

Comparing Data

The `while` Statement

Iterators

The `ArrayList` Class

Determining Event Sources

Check Boxes and Radio Buttons

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Iterators

- An *iterator* is an object that allows you to process a collection of items one at a time
- It lets you step through each item in turn and process it as needed
- An iterator has a `hasNext` method that returns true if there is at least one more item to process
- The `next` method returns the next item
- Iterator objects are defined using the `Iterator` interface, which is discussed further in Chapter 7

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Iterators

- Several classes in the Java standard class library are iterators
- The `Scanner` class is an iterator
  - the `hasNext` method returns true if there is more data to be scanned
  - the `next` method returns the next scanned token as a string
- The `Scanner` class also has variations on the `hasNext` method for specific data types (such as `hasNextInt`)

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Iterators

- The fact that a `Scanner` is an iterator is particularly helpful when reading input from a file
- Suppose we wanted to read and process a list of URLs stored in a file
- One scanner can be set up to read each line of the input until the end of the file is encountered
- Another scanner can be set up for each URL to process each part of the path
- See `URLDissector.java`

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```
//********************************************************************
//  URLDissector.java       Author: Lewis/Loftus
//
//  Demonstrates the use of Scanner to read file input and parse it
//  using alternative delimiters.
//********************************************************************

import java.util.Scanner;
import java.io.*;

public class URLDissector
{
   //-----------------------------------------------------------------
   //  Reads urls from a file and prints their path components.
   //-----------------------------------------------------------------
   public static void main(String[] args) throws IOException
   {
      String url;
      Scanner fileScan, urlScan;

      fileScan = new Scanner(new File("urls.inp"));
```

continue

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continue

```
        // Read and process each line of the file
        while (fileScan.hasNext())
        {
           url = fileScan.nextLine();
           System.out.println("URL: " + url);

           urlScan = new Scanner(url);
           urlScan.useDelimiter("/");

           //  Print each part of the url
           while (urlScan.hasNext())
              System.out.println ("   " + urlScan.next());

           System.out.println();
        }
     }
}
```

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continue

```
        // Rea
        while
        {
            url
            Sys

            url
            url

            //
            whi


            Sys
        }
    }
}
```

Sample Run

```
URL: www.google.com
   www.google.com

URL: www.linux.org/info/gnu.html
   www.linux.org
   info
   gnu.html

URL: thelyric.com/calendar/
   thelyric.com
   calendar

URL: www.cs.vt.edu/undergraduate/about
   www.cs.vt.edu
   undergraduate
   about

URL: youtube.com/watch?v=EHCRimwRGLs
   youtube.com
   watch?v=EHCRimwRGLs
```

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Outline

- **Boolean Expressions**
- **The `if` Statement**
- **Comparing Data**
- **The `while` Statement**
- **Iterators**
- **The `ArrayList` Class**
- **Determining Event Sources**
- **Check Boxes and Radio Buttons**

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The ArrayList Class

- An `ArrayList` object stores a list of objects, and is often processed using a loop
- The `ArrayList` class is part of the `java.util` package
- You can reference each object in the list using a numeric index
- An `ArrayList` object grows and shrinks as needed, adjusting its capacity as necessary

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The ArrayList Class

- Index values of an `ArrayList` begin at 0 (not 1):

0	"Bashful"
1	"Sleepy"
2	"Happy"
3	"Dopey"
4	"Doc"

- Elements can be inserted and removed
- The indexes of the elements adjust accordingly

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ArrayList Methods

- Some `ArrayList` methods:

```
boolean add(E obj)

void add(int index, E obj)

Object remove(int index)

Object get(int index)

boolean isEmpty()

int size()
```

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The ArrayList Class

- The type of object stored in the list is established when the `ArrayList` object is created:

```
ArrayList<String> names = new ArrayList<String>();

ArrayList<Book> list = new ArrayList<Book>();
```

- This makes use of Java *generics*, which provide additional type checking at compile time
- An `ArrayList` object cannot store primitive types, but that's what wrapper classes are for
- See `Beatles.java`

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```
//********************************************************************
//  Beatles.java       Author: Lewis/Loftus
//
//  Demonstrates the use of a ArrayList object.
//********************************************************************

import java.util.ArrayList;

public class Beatles
{
   //-----------------------------------------------------------------
   //  Stores and modifies a list of band members.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      ArrayList<String> band = new ArrayList<String>();

      band.add("Paul");
      band.add("Pete");
      band.add("John");
      band.add("George");
```

continue

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continue

```
        System.out.println(band);
        int location = band.indexOf("Pete");
        band.remove(location);

        System.out.println(band);
        System.out.println("At index 1: " + band.get(1));
        band.add(2, "Ringo");

        System.out.println("Size of the band: " + band.size());
        int index = 0;
        while (index < band.size())
        {
           System.out.println(band.get(index));
           index++;
        }
    }
}
```

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continue

```
        System.out.p
        int locatior
        band.remove

        System.out.p
        System.out.p                                    (1));
        band.add (2,

        System.out.p                                    nd.size());
        int index =
        while (index < band.size())
        {
            System.out.println(band.get(index));
            index++;
        }
    }
}
```

Output

```
[Paul, Pete, John, George]
[Paul, John, George]
At index 1: John
Size of the band: 4
Paul
John
Ringo
George
```

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Outline

Boolean Expressions

The `if` Statement

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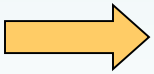
The `ArrayList` Class



Determining Event Sources

Check Boxes and Radio Buttons

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Determining Event Sources

- Recall that interactive GUIs require establishing a relationship between components and the listeners that respond to component events
- One listener object can be used to listen to two different components
- The source of the event can be determined by using the `getSource` method of the event passed to the listener
- See `LeftRight.java`
- See `LeftRightPanel.java`

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```
//********************************************************************
//  LeftRight.java       Authors: Lewis/Loftus
//
//  Demonstrates the use of one listener for multiple buttons.
//********************************************************************

import javax.swing.JFrame;

public class LeftRight
{
   //-----------------------------------------------------------------
   //  Creates the main program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Left Right");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      frame.getContentPane().add(new LeftRightPanel());

      frame.pack();
      frame.setVisible(true);
   }
}
```

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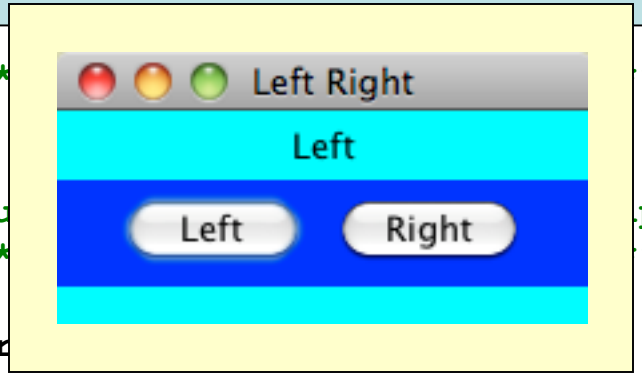


```
//********************                                    ********************
//  LeftRight.java
//
//  Demonstrates the u                                  ple buttons.
//********************                                    ********************

import javax.swing.JFr

public class LeftRight
{
   //-----------------------------------------------------------------
   //  Creates the main program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Left Right");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      frame.getContentPane().add(new LeftRightPanel());

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  LeftRightPanel.java       Authors: Lewis/Loftus
//
//  Demonstrates the use of one listener for multiple buttons.
//********************************************************************

import java.awt.*;
import java.awt.event.*;
import javax.swing.*;

public class LeftRightPanel extends JPanel
{
   private JButton left, right;
   private JLabel label;
   private JPanel buttonPanel;
```

continue

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continue

```
//-----------------------------------------------------------------
//  Constructor: Sets up the GUI.
//-----------------------------------------------------------------
public LeftRightPanel()
{
   left = new JButton("Left");
   right = new JButton("Right");

   ButtonListener listener = new ButtonListener();
   left.addActionListener(listener);
   right.addActionListener(listener);

   label = new JLabel("Push a button");

   buttonPanel = new JPanel();
   buttonPanel.setPreferredSize(new Dimension(200, 40));
   buttonPanel.setBackground(Color.blue);
   buttonPanel.add(left);
   buttonPanel.add(right);

   setPreferredSize(new Dimension(200, 80));
   setBackground(Color.cyan);
   add(label);
   add(buttonPanel);
}
```

continue

n, Inc.

continue

```
   //*****************************************************************
   //  Represents a listener for both buttons.
   //*****************************************************************
   private class ButtonListener implements ActionListener
   {
      //--------------------------------------------------------------
      //  Determines which button was pressed and sets the label
      //  text accordingly.
      //--------------------------------------------------------------
      public void actionPerformed(ActionEvent event)
      {
         if (event.getSource() == left)
            label.setText("Left");
         else
            label.setText("Right");
      }
   }
}
```

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Outline

Boolean Expressions

The `if` Statement

Comparing Data

The `while` Statement

Iterators

The `ArrayList` Class

Determining Event Sources

Check Boxes and Radio Buttons

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Check Boxes

- A *check box* is a button that can be toggled on or off
- It is represented by the `JCheckBox` class
- Unlike a push button, which generates an action event, a check box generates an *item event* whenever it changes state
- The `ItemListener` interface is used to define item event listeners
- A check box calls the `itemStateChanged` method of the listener when it is toggled

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Check Boxes

- Let's examine a program that uses check boxes to determine the style of a label's text string
- It uses the `Font` class, which embodies a character font's:
  - family name (such as Times or Courier)
  - style (bold, italic, or both)
  - font size
- See `StyleOptions.java`
- See `StyleOptionsPanel.java`

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```
//********************************************************************
//  StyleOptions.java       Author: Lewis/Loftus
//
//  Demonstrates the use of check boxes.
//********************************************************************

import javax.swing.JFrame;

public class StyleOptions
{
   //-----------------------------------------------------------------
   //  Creates and presents the program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Style Options");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      StyleOptionsPanel panel = new StyleOptionsPanel();
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//*****************                                    **************
//  StyleOptions.
//
//  Demonstrates
//*****************                                    **************

import javax.swin

public class StyleOptions
{
   //-------------                                     -------------
   //  Creates an
   //-------------                                     -------------
   public static
   {
      JFrame fram
      frame.setDe                                          SE);

      StyleOption
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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```
//********************************************************************
//  StyleOptionsPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of check boxes.
//********************************************************************

import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class StyleOptionsPanel extends JPanel
{
   private JLabel saying;
   private JCheckBox bold, italic;
```

continue

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continue

```
//-----------------------------------------------------------------
//  Sets up a panel with a label and some check boxes that
//  control the style of the label's font.
//-----------------------------------------------------------------
public StyleOptionsPanel()
{
   saying = new JLabel("Say it with style!");
   saying.setFont(new Font("Helvetica", Font.PLAIN, 36));

   bold = new JCheckBox("Bold");
   bold.setBackground(Color.cyan);
   italic = new JCheckBox("Italic");
   italic.setBackground(Color.cyan);

   StyleListener listener = new StyleListener();
   bold.addItemListener(listener);
   italic.addItemListener(listener);

   add(saying);
   add(bold);
   add(italic);

   setBackground(Color.cyan);
   setPreferredSize(new Dimension(300, 100));
}
```

continue

, Inc.

continue

```
   //*****************************************************************
   //  Represents the listener for both check boxes.
   //*****************************************************************
   private class StyleListener implements ItemListener
   {
      //--------------------------------------------------------------
      //  Updates the style of the label font style.
      //--------------------------------------------------------------
      public void itemStateChanged(ItemEvent event)
      {
         int style = Font.PLAIN;

         if (bold.isSelected())
            style = Font.BOLD;

         if (italic.isSelected())
            style += Font.ITALIC;

         saying.setFont(new Font("Helvetica", style, 36));
      }
   }
}
```

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Radio Buttons

- A group of *radio buttons* represents a set of mutually exclusive options – only one can be selected at any given time
- When a radio button from a group is selected, the button that is currently "on" in the group is automatically toggled off
- To define the group of radio buttons that will work together, each radio button is added to a `ButtonGroup` object
- A radio button generates an action event

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Radio Buttons

- Let's look at a program that uses radio buttons to determine which line of text to display

- See `QuoteOptions.java`
- See `QuoteOptionsPanel.java`

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```
//********************************************************************
//  QuoteOptions.java       Author: Lewis/Loftus
//
//  Demonstrates the use of radio buttons.
//********************************************************************

import javax.swing.JFrame;

public class QuoteOptions
{
   //-----------------------------------------------------------------
   //  Creates and presents the program frame.
   //-----------------------------------------------------------------
   public static void main(String[] args)
   {
      JFrame frame = new JFrame("Quote Options");
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

      QuoteOptionsPanel panel = new QuoteOptionsPanel();
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```

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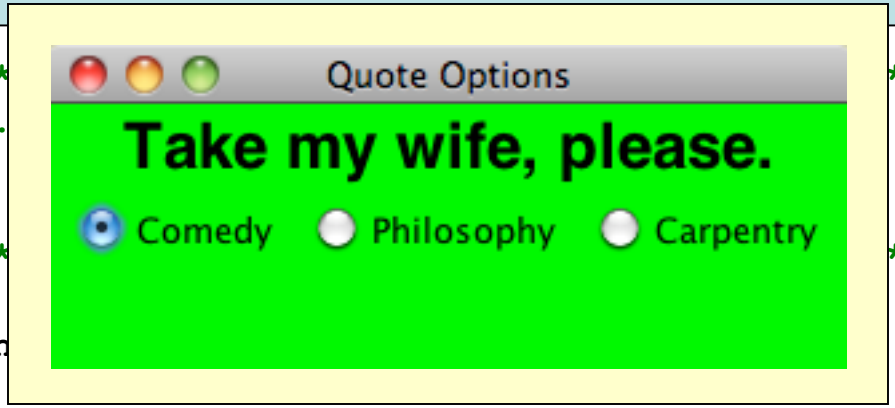
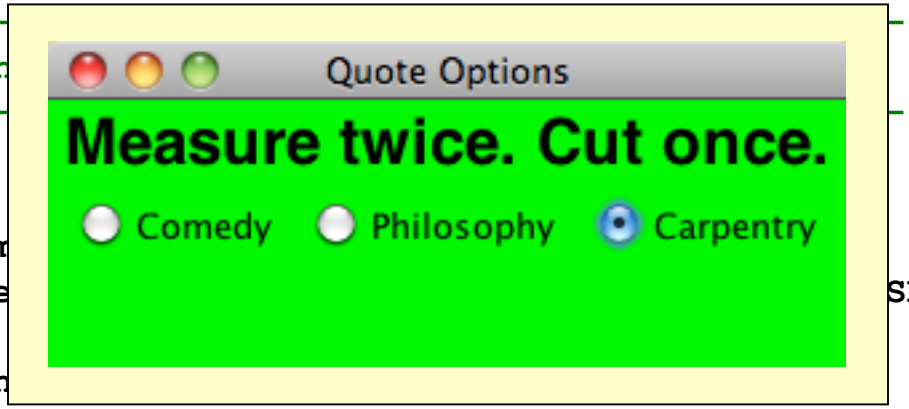
```
//*****************
//  QuoteOptions.
//
//  Demonstrates
//*****************

import javax.swin

public class QuoteOptions
{
   //-------------
   //  Creates an
   //-------------
   public static
   {
      JFrame fram
      frame.setDe

      QuoteOption
      frame.getContentPane().add(panel);

      frame.pack();
      frame.setVisible(true);
   }
}
```





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```
//********************************************************************
//  QuoteOptionsPanel.java       Author: Lewis/Loftus
//
//  Demonstrates the use of radio buttons.
//********************************************************************

import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class QuoteOptionsPanel extends JPanel
{
   private JLabel quote;
   private JRadioButton comedy, philosophy, carpentry;
   private String comedyQuote, philosophyQuote, carpentryQuote;

   //-----------------------------------------------------------------
   //  Sets up a panel with a label and a set of radio buttons
   //  that control its text.
   //-----------------------------------------------------------------
   public QuoteOptionsPanel()
   {
      comedyQuote = "Take my wife, please.";
      philosophyQuote = "I think, therefore I am.";
      carpentryQuote = "Measure twice. Cut once.";

      quote = new JLabel(comedyQuote);
      quote.setFont(new Font("Helvetica", Font.BOLD, 24));
```

continue

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continue

```
        comedy = new JRadioButton("Comedy", true);
        comedy.setBackground(Color.green);
        philosophy = new JRadioButton("Philosophy");
        philosophy.setBackground(Color.green);
        carpentry = new JRadioButton("Carpentry");
        carpentry.setBackground(Color.green);

        ButtonGroup group = new ButtonGroup();
        group.add(comedy);
        group.add(philosophy);
        group.add(carpentry);

        QuoteListener listener = new QuoteListener();
        comedy.addActionListener(listener);
        philosophy.addActionListener(listener);
        carpentry.addActionListener(listener);

        add(quote);
        add(comedy);
        add(philosophy);
        add(carpentry);

        setBackground(Color.green);
        setPreferredSize(new Dimension(300, 100));
    }
```

continue

n, Inc.

continue

```
    //*****************************************************************
    //  Represents the listener for all radio buttons
    //*****************************************************************
    private class QuoteListener implements ActionListener
    {
       //--------------------------------------------------------------
       //  Sets the text of the label depending on which radio
       //  button was pressed.
       //--------------------------------------------------------------
       public void actionPerformed(ActionEvent event)
       {
          Object source = event.getSource();

          if (source == comedy)
             quote.setText(comedyQuote);
          else
             if (source == philosophy)
                quote.setText(philosophyQuote);
             else
                quote.setText(carpentryQuote);
       }
    }
}
```

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Summary

- Chapter 5 focused on:
  - boolean expressions
  - the if and if-else statements
  - comparing data
  - while loops
  - iterators
  - more drawing techniques
  - more GUI components

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